SPACE PROPULSION SYMPOSIUM (C4)
Joint Session on Advanced and Nuclear Power and Propulsion Systems (7-C3.5)

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NEW POSSIBILITIES OF SOLAR POWER PROPULSION SYSTEMS

Abstract

Capabilities of conventional liquid propulsion are close to the limiting, therefore new high-efficient technologies are required for raise of space vehicles efficiency. In particular, it is possible to use solar energy for raise of propulsive mass (hydrogen) enthalpy in solar thermal power propulsion systems (SPPS), belonging to the class of power propulsion systems of restricted thrust (from several tens to hundreds Newton, intermediate between liquid propulsion and electric propulsion). Specific impulse of SPPS can more than twice exceed that for liquid propulsion (700…900 sec).

Solar thermal power propulsion systems are considered as means of inter-orbital transportation from LEO to GEO and power supply for payload at the target orbit. Time of payload delivery for ordinary observed SPPS reaches 60 days and more. The suggested SPPS contains high-temperature concentrator-absorber system (CAS) as a power source, with possibility of use of multi-staged absorber of non-isothermal type with higher optical-power efficiency. Ballistic efficiency of upper stage with such SPPS grows with increase of extent of non-isothermal properties of the CAS and can be two times higher as compared to efficiency of liquid propulsion. Efficiency of upper stage with the SPPS is depended by such relevant parameters of the CAS as sunlight concentration ratio and hydrogen temperature of heating in the absorber-heat exchanger as well as permissible conditions of the Sun tracking system. The expedient CAS parameters values are presented for LEO-to-GEO flight mission. The possible power levels for payload supply at GEO for the case of the considered SPPS use and different power converters are observed. The possibility of obtaining of high power-to-weight ratio exceeding 5…6 kWatt per ton for payload injected into GEO, when the suggested SPPS use, is shown.

Considering that space power propulsion systems using combination of engines of large and low thrust at comparable trip time (60…120 days) can be the competing means of inter-orbital transportation for the SPPS, it is expedient to estimate ballistic efficiency of the solar upper stage at lower flight time. Simulation of the considered task shows the possibilities of reduction of payload injection time up to 20…40 days at high ballistic efficiency of the suggested solar upper stage with extreme-non-isothermal multi-staged CAS. At short inter-orbital transfer time the optimal SPPS relevant parameters changes towards the CAS simplification, i.e. the optimal optical accuracy of the CAS reduces as well as the optimal heating temperature of hydrogen. The Sun tracking conditions are also simplified.